ADDRESS.

Delivered by the President, Lord Lindsay, on Presenting the Gold Medal of the Society to Professor Asaph Hall, U.S. Navy.

Your Council has this year awarded the Gold Medal of the Society to Professor Asaph Hall

For his discovery and observations of the satellites of *Mars*, and his determinations of their orbits.

It has been usual for your President to state the reasons which have influenced the Council in their awards, and to give a brief history of the discovery, or research, which they have held worthy of such high esteem, and, in following the example of my predecessors in office, I would crave your indulgence if I slightly deviate from custom in one particular.

I allude to some of the work of your Medallist which had rendered his name already familiar at the time he announced his great discovery to the world.

An examination of the writings of Professor Hall show that there are but few departments of astronomy to which he has not paid some attention, combining the skill of the observer with the labours of the mathematician.

From 1858 to the present time almost every volume of the *Astronomische Nachrichten* contains notices of his zealous observation of minor planets and comets. Not content with mere observation, he has in many cases given ephemerides, and has calculated elements, among which may be noticed those of (60), (66), (73), (81), (124), all of them refined pieces of work based on normal places, and in some instances taking into account the perturbations due to *Jupiter* and *Saturn*.

The early history of Mr. Hall affords a bright example of what perseverance and determination may effect in overcoming even the most adverse circumstances.

Born at Goshen on October 15, 1829, Mr. Hall received his early education at the hands of his father and at the village school. In 1842 he was left an orphan, and from comparative affluence he was reduced to work for his living. He served for some time as an apprentice to a carpenter, devoting his leisure hours to the study of geometry and algebra.

In 1856 he studied one term under Brünnow at the Michigan University, whence he went to Cambridge, Mass., and entered the Observatory under Professor W. C. Bond. He applied himself with the greatest diligence to all matters connected with the Observa-

tory, as he was determined—to use his own words—to make himself so useful that they would not care to let him go. Strong and in good health, he found time to study, and worked hard on orbits and the theory of perturbations. He remained at Cambridge until August 1862, when he was appointed one of the aids in the Naval Observatory, Washington, and in May the year following he was commissioned Professor of Mathematics.

In 1863 he published a Memoir on the Solar Parallax deduced from observations of *Mars*, with equatoreal instruments, made at Upsala, Santiago, Washington. Combining all the results, he found,

From Upsala and Santiago	$\pi = 8''\cdot859$	*w.* 43·81
Washington and Santiago	$\pi = 8''\cdot810$	*w.* 24·60,

with the concluded result of all the observations of *Mars* in 1869,

$$\pi = 8''\cdot8415.$$

This Memoir he supplemented in 1866 by an examination of 1181 observations used for the parallax determination, and showed conclusively that the method of observing the planet on two wires sufficiently wide apart to cut off small segments of the planet's disk is far preferable to the method of tangents.

In a Memoir communicated to the *Astronomische Nachrichten*, No. 71, p. 191, on the "Positions of the Fundamental Stars," he offers some very sound suggestions, considering that these determinations should be made a *special problem*, to which the undivided attention of the observer should be given. He considers that the instrument should not exceed 5 inches aperture, with circles not greater than 30 inches, and that the objectives and occulars should be interchangeable, in order to eliminate as far as possible constant errors and flexure. Each series of observations should be made by a single observer, who should be an experienced astronomer. He goes on to show, if the number of stars were small, limited perhaps to the 47 chief stars of the *Berliner Jahrbuch* with the addition of a few circumpolar stars, that their positions might be advanced to a degree of accuracy almost hopeless under the present methods of observing.

Your Medallist this year (1868) made a remarkable observation of an occultation of *Aldebaran*, the immersion of which was seen at $0^h\ 3^m\ 10^s\cdot6$ Washington mean time. The Moon was invisible at the time and the star was only 8° 12′ from the Sun's centre. This occultation, though given in the *Jahrbuch* and in the *Monthly Notices*, was not in either the American or English *Nautical Almanacs*, nor in the *Connaissance des Temps*.

Professor Hall was sent by his Government to observe the solar eclipses of 1869 and 1870, and though his notes on these observations are interesting, I will not dwell upon them, as they will be fully treated in vol. xli. of your *Memoirs*.

In 1870 he sent an interesting paper to *Silliman's Journal* on the secular perturbations of the planets.

Following the steps of Lagrange, he points out, as had been already done by Leverrier, that the final equations from which the secular perturbations are derived rise to the degree denoted by the number of planets considered and in our system will be of the eighth degree. The conditions necessary for the stability of the system are, first, that the eight roots of the equation for "g" (on which depend the excentricity and the longitude of the perihelion) shall be real and unequal, in order that there may be no terms, outside the circular functions, containing the time as a factor or exponent, which therefore would increase indefinitely; and, secondly, it is necessary that the coefficients, determined by the initial values of the excentricity and perihelion, may not be great, in order that the excentricity may not increase so as to render divergent, the series, which have been assumed in the solution to be rapidly convergent.

When it is required to compute for very remote epochs, he shows that the value of the coefficients of "g" which are multiplied by the time must be very carefully considered. These depend on the values of the assumed masses of the planets, and are usually determined by neglecting terms of the third order.

Leverrier shows that the terms of the third order may produce corrections of the values of "g" amounting to three or four-tenths of a second; probable uncertainties in the assumed values of the masses of the planets may give rise to errors of nearly two tenths of a second. Thus it is evident that for remote epochs calculations must be untrustworthy, since when the time is great the errors in the value of "g" may completely change the character of the circular functions.

Professor Hall next points out that, to obtain satisfactory solutions to the problem, our knowledge of the planets' masses must be greatly increased.

Assuming that in time the masses of *Mars* and *Jupiter* will be accurately learnt from the theories of some of the minor planets, he considers that we have to our hand the instrumental means of making accurate determinations of the masses of *Saturn*, *Uranus*, and *Neptune* by a more complete investigation of the theories of their satellites.

Now follows the only passage I have found in which I cannot entirely agree with your Medallist. He says:—"When the novel and entertaining observations with the spectroscope have received their natural abatement, and have been assigned their proper place, it is to be hoped that some of the powerful telescopes recently constructed may be devoted to this class of observation."

The volume of the *Washington Observations* for 1867 contains a valuable catalogue of 151 stars in *Præsepe* whose places Professor Hall determined by comparison with eleven standard stars. The observations were made with the Equatoreal, and

beginning in 1864, were completed in the spring of 1870. In observing, the telescope was clamped in R.A. but free in Decl. The probable errors are $\pm 0^{s}.043$ and $\pm 0''.46$. Bright wires and dark field were used throughout, with a power of 132.

In 1871, in *Silliman's Journal*, we have an interesting paper from Professor Hall on the "Astronomical Proof of a Resisting Medium in Space."

Your Medallist shows, from the investigations of Möller and Oppolzer, that the comets of Faye and Winnecke do not by their motions give any indications of the presence of a resisting medium such as Encke assumed to exist.

It is possible that Professor Hall does not dwell sufficiently on the fact that the perihelion distance of Encke's comet is much less than that of either of the others, and that a resisting medium increasing in density in the neighbourhood of the Sun would account for the anomalies in the motion of the comet (Encke's) without affecting Faye's. It would seem, too, that the perturbations of Winnecke's comet have hardly been investigated with all the accuracy required to decide so delicate a question; added to this, the effect of a resisting medium would be much greater on a rapidly moving comet like Encke's. I need hardly say, however, that the whole problem is surrounded with difficulty.

The most interesting paper which Professor Hall has communicated to our Society is to be found in vol. xxxiii. of the *Monthly Notices*; it is on the "Determination of Longitudes by Moon Culminations." He shows here that such determinations are liable to large constant errors. Assuming the telegraphic longitude of San Francisco to be correct (which may safely be done), the determination from 206 Moon culminations was found to be four seconds in error. Treating of the difference of longitude between Washington and Greenwich, he gives the following table:—

Authority.	No. of Culm.	Longitude. h m s	Errors. s
Loomis	150	5 8 9·3	−2·9
Gillis	394	10·0	−2·2
Walker	...	9·6	−2·6
Newcombe	279	11·6	−0·6
Newcombe	163	9·8	−2·4

The conclusions he draws from this investigation are that all determinations derived from Moon culminations, occultations, and solar eclipses give the difference of longitude smaller than the telegraphic value, $5^{h}\ 8^{m}\ 12^{s}.2$, which he assumes to be the correct value.

The *Astronomische Nachrichten* for 1875, vol. 86, contains several papers by your Medallist. He proposes to utilise the observations of the minor planets to determine the mass of

Mars. Starting from certain formulæ in the *Mécanique Céleste*, he shows which planets would give the best results. It seems probable that the method has lost little or none of its value by the discovery of the satellites, as it seems to be one of the best for giving an independent value.

In treating the Washington observations of *Flora* (8) in 1873, he refers to the determination of the solar parallax according to the method proposed by Professor Galle, demonstrating that an uncertainty of measurement at either of the stations would vitiate the whole angle. He points out, without attempting to explain, the discrepancies which are found to exist between the Observatories of Lund and Dublin in the *Flora* observations of 1873, which are $-0''\cdot055$; $+0''\cdot080$; $+0''\cdot330$; $-0''\cdot816$; and $+0''\cdot965$. "Whatever may be the cause of these differences between skilled observers, they tend to cast a doubt on the reality of the small quantities which are found in the investigation of stellar parallax."

On December 7, 1876, your Medallist noticed a bright spot on the ball of *Saturn*; on the next day letters were sent to astronomers in different parts of the country, asking them to assist in observing it. It was last seen on January 2, 1877. He combined eighteen observations thus obtained into nine, from which he found the time of rotation of *Saturn* to be

$$10^{h}\ 14^{m}\ 23^{s}\cdot8 \pm 2^{s}\cdot30 \quad \text{Mean time.}$$

Sir William Herschel had found $10^{h}\ 16^{m}\ 0^{s}\cdot4$, and concluded that this time cannot be in error so much as two minutes. The greater number of the textbooks had $10^{h}\ 29^{m}\ 16^{s}\cdot8$, and, by a strange error, Sir J. Herschel, in his *Outlines*, gives $9^{h}\ 57^{m}\ 1^{s}\cdot91$, which is the sidereal time of the rotation of *Jupiter*.

In a general investigation of the problem of the shadow of a planet, originating in a wish to determine the form of the shadow of the ball of *Saturn* on the ring, he points out that in a special case the shadow may be sensibly a straight line.

I have thus very briefly brought before you the labours of Professor Hall up to the time of the important discovery for which your Council has awarded him the Medal, and I will now in a few words refer to the unsuccessful searches for satellites of *Mars* which had been made previously to the opposition of 1877.

In 1830 Mädler searched in vain for a satellite of *Mars* during the favourable opposition of that year, and came to the conclusion that if such a satellite existed, and if it possessed the same reflecting power as its primary, it could not exceed the diameter of some 20 miles, since a larger one could not escape discovery under favourable circumstances.

The instrument employed in this search was of $3\frac{3}{4}$ inches aperture, and was the same he afterwards employed in his lunar work; and though at the time the conclusions thus drawn were considered hardly justifiable still, as time wore on and larger

instruments were employed, Mädler's estimate obtained better consideration.

Professor D'Arrest made a search for a satellite in the year 1864. This was again unsuccessful. In a paper in the *Astronomische Nachrichten*, vol. lxiv., p. 74, D'Arrest, assuming the distance of *Mars* from the Earth to be 0·52 and with an assumed mass for the planet, computed the apparent elongation of a satellite which would revolve around the planet in a given time. Thus he showed that an elongation of 70′ would give the satellite a period greater than the period of *Mars* round the Sun, or in other words, greater than 687 days. From this the inference was drawn that it is useless to search for a satellite at a greater distance than 70′.

There is also another note on this subject which seems to have escaped the researches of your Medallist. It occurs in *Stjernehimlen*, by F. Kaiser, translated from the third Dutch edition into Danish by Mathilde Oersted, with a preface by D'Arrest. *Copenhagen*, 1867.

On page 423, note 7, there is the following remarkable passage, which, though nominally by the translator, was probably inspired by Professor D'Arrest:—

"That up to the present time no satellite of *Mars* has been found may possibly be owing to the fact that such a satellite, from the nature of the case, must be very near to its primary, and that any faint star becomes totally extinguished and rendered invisible in the immediate neighbourhood of the brilliant planet.

"Formerly it was the custom to explain the same fact by the contrary reason, viz. by pointing out how difficult it must be to find a satellite of *Mars* at a possibly great distance from the planet. However, by reason of the planet's small mass, this can by no means be the case."

The failures of distinguished observers almost discouraged your Medallist from instituting a fresh search, and the low declination of the planet gave promise of better results for Observatories in the southern hemisphere. However, calling to mind the great optical power and excellence of the Clark Refractor, and encouraged by his wife, Professor Hall thought that there might be a slight hope remaining for ultimate success.

Early in August the geocentric motion of *Mars* being such as to render the detection of a satellite comparatively easy, the search was commenced in earnest. Commencing with faint objects at a considerable distance from the planet, it was soon found that they were nothing but fixed stars, and on August 10 Professor Hall began to "examine the region close to the planet and within the glare of light which surrounded it." Keeping the disk of *Mars* just outside the field of view, sweeps were made all round the planet; but as the definition was very bad, and (as was afterwards learned) the satellites being very near at the time, nothing was found.

The next night, August 11, the observations were resumed, the same method of sweeping being adopted. At $14^h 30^m$ your Medallist made the discovery of the outer satellite, a faint object N.F. He had hardly time to complete the observation of position when fog rising from the Potomac river stopped his work. Until the 15th bad weather hindered further observation, and though search was made at 11^h, it was unavailing, the proximity of the satellite to *Mars* rendering it invisible.

On August 16 the satellite was again found on the north following side of the planet, and the observations of this night demonstrated clearly that it was moving with *Mars*, and that, if a satellite, that it was near one of its elongations. It was on the night following, August 17, that, while waiting for and watching the outer satellite, Professor Hall discovered the inner one, and obtained measures of it when at a distance of about 31″ from the centre of the planet.

The last doubts as to the character of the faint objects thus found having been dispelled by the observations of August 17 and 18, the discovery was officially announced by Admiral Rodgers. The appearances of the minor satellite were most perplexing, and I cannot do better than quote the words of Professor Hall. He says: "Still for several days the inner moon was a puzzle. It would appear on different sides of the planet on the same night, and at first I thought that there were two or three inner moons, since it seemed to me at that time very improbable that a satellite should revolve round its primary in less time than that in which the primary rotates."

To set this point at rest Professor Hall watched the satellite throughout the nights of August 20 and 21, and was satisfied that there was but one inner moon, which performed its revolution in less than one-third of the time of the rotation of *Mars*, a case, as he observes, unique in our solar system.

Such, in a few words, is the history of a great astronomical discovery; and it is satisfactory to think that the United States Government has received a reward already for the enlightened munificence displayed in placing so magnificent an instrument in the hands of one so capable of using it.

Of the many names suggested for these moons, your Medallist selected those proposed by Mr. Madan, of Eton—*Deimos* for the outer, *Phobos* for the inner satellite.

The labours attending this search by no means ceased with the attainment of the object in view. For your Medallist, not merely content to publish his crude observations, has reduced them, and from the results has given the elements of the orbits of the satellites.

It would, perhaps, be well to describe the method of observation at this point. Professor Hall commences by saying that, as the satellites were faint objects and were always immersed in the glare of light surrounding the planet, the observations were made with difficulty.

'The *modus operandi* was as follows :—The disk of the planet was bisected by one wire of the micrometer as nearly as the eye could judge, while the other was laid on the satellite. As it rarely occurred that both planet and satellite could be seen in the field of view together, it was usually necessary to use the slipping piece of the micrometer, the eye-piece being moved to and fro until the two bisections appeared to be satisfactory. Though at first Professor Hall would have preferred to have had a pair of wires inserted, by which small equal segments of *Mars* could have been cut off, in the manner described in his paper to the *Astronomische Nachrichten*, vol. lxviii., p. 235, he was not willing to break in on his work, and he states that experience has given him confidence in the method he adopted.

The observations thus obtained give polar coordinates or the angle of position and distance referred to the centre of gravity of the apparent disk of the planet, involving corrections for differential refraction and for the figure of the true disk.

For the refraction correction the formulæ, given by Bessel in the *Astronomische Untersuchungen*, vol. i., p. 165, have been used; and the formula,

$$m = \frac{8a}{3\pi} \sin \frac{1}{2} \phi^2,*$$

gives the reduction from the centre of gravity of the illuminated disk to the centre of the true disk.

It will be noticed here that no allowance is made for the varying intensity of illumination of different parts of the disk;

* Where m denotes the distance of the centre of gravity from the centre of the line of cusps,

and ϕ = the angle at the planet;

a = radius of the semicircular part of the disk,

and π = the number 3·14159.

"p" and "s," as usual, denoting the observed angles of position and the distance of the satellite, and "θ" the angle of position of the line of cusps, the errors of p and s arising from the figure of the disk are found by the formulæ—

$$\Delta p = \frac{m}{s} \cos (p-\theta),$$

$$\Delta s = m \sin (p-\theta).$$

A note on this formula was communicated to the Society by Professor Hall and will be found in vol. xxxviii., p. 122, of the *Monthly Notices*. I see that the formula has been there printed

$$m = \frac{8a}{3\pi} \sin^2 \frac{1}{2} \phi$$

$$\text{for} \quad m = \frac{8a}{3\pi} \sin \frac{1}{2} \phi^2.$$

any error, however, due to this cause would have contrary effects before and after opposition.

The observations and the corrections thus found, $\Delta\rho$, Δp, $\Delta\rho$, and Δs, are given, and are found to consist of—

For *Deimos*,

52	observations,	made on	31	nights,	involving	185	comparisons, in position;
50	„	„	31	„	„	137	„ in distance.

While for *Phobos* we have

36	„	„	25	„	„	123	„ in position;
43	„	„	25	„	„	97	„ in distance.

With the exception of three observations of *Deimos*, made by Professors Newcomb, Harkness, and Holden, the whole series were taken by your Medallist.

For convenience in reduction, the times of the observations were then transferred to the meridian of Greenwich, corrected for aberration, and reduced to decimals of a day.

Although many other observations at different Observatories have been made, no series was so complete as that made at the Naval Observatory, Washington; and your Medallist, considering the difficulty of the observations and the probability of each observer having a constant personal error, decided that it would be unwise to throw all the observations at his disposal into one mass; therefore the elements of the satellites are based upon his own observations alone.

The method of computation is as follows:—Taking the observations near opposition and carefully projecting them, he determined the form of the orbits (which were assumed to be circular). The ratio between the axes of the apparent ellipse gives the angle between the line of sight and the plane of the orbit. This, combined with the position angle of the major axis and the place of the planet, gives the inclination of the orbit to the Equator, and also the ascending node on the Equator.

There seems to be an error in the definition of θ at the top of p. 16 of his paper, "Observations and Orbits of the Satellites of Mars &c." Instead of "angle between the orbit plane and the plane perpendicular to the line of sight," we should read "angle between the orbit plane and the line of sight." If this were not so, the formula would run $\cos\theta = \frac{b}{a}$. It will also be perceived that Professor Hall says nothing as to how the approximate period was found. This, however, was probably obtained by combining extreme observations.

From these data he obtained the approximate circular elements, in which

μ is the number of degrees of angular motion in one day.
a the apparent major axis of the orbit seen from a distance unity;
I inclination of the orbits to the Earth's equator } same for both satellites
N the longitudes of the ascending nodes }
u the angular distance of the satellite from the node at the epoch.

He then compared the observations with these elements, using Bessel's methods for facilitating the calculation of the positions of the satellites.

He next formed differential equations—98 in the case of *Deimos* and 79 in the case of *Phobos*—for the correction of the following elements:—

The longitude of the node;
The inclination of orbit to Earth's equator;
Longitude at epoch;
Mean angular motion;
Two terms dependent on the excentricity and the line of apsides; and finally, in the case of the distances,
A term dependent on the major axis.

Had this part of the work been carried out in polar coordinates as it was commenced, it would have been perhaps preferable as the more elegant, though in passing to rectilinear your Medallist has followed in the steps of good men, such as Newcomb, von Asten, and Bessel himself.

The coefficients of the equations of condition were computed by Dr. C. Powalky, and were checked by Professor Hall. It will be seen that the normal equations are not given.

The resulting corrections are in general small, the sums of the squares of the residuals being, in the case of *Deimos* 29·07, and for *Phobos* 23·09; whence the probable error of a single observation is found to be, for *Deimos* 0″·391, and for *Phobos* 0″·412.

The excentricity of the orbit of *Phobos* is about $\frac{1}{30}$th, with a probable error of about $\frac{1}{600}$th, and your Medallist most justly concludes that it must be real.

The excentricity of the orbit of *Deimos* is so small that we may consider the circular element of this satellite as practically sufficient for the observations.

An examination of the equations for *Deimos* shows the largest outstanding residuals on August 17. The comparisons and reductions for this date were examined, but no error was found, and your Medallist preferred to let them stand with this remark:—

"The method of rejecting observations after the comparison by means of criterions which are based on the residuals and the probable errors seems to me to rest on a false logic and to lead to the dangerous practice of trimming observations for the purpose

of procuring an apparently accurate result, which, in fact, may be wide of the truth."

The smallness of the probable error of a single observation is the best proof we can have, showing a high degree of accuracy, considering how faint the objects are and under what difficulties the observations were made.

We now come to what may be considered the most important outcome of your Medallist's brilliant discovery, viz. the determination of the mass of *Mars*.

The result he obtains from *Deimos* gives

$$M = \frac{1}{3095313 \mp 3485},$$

and from *Phobos*

$$M = \frac{1}{3078456 \mp 10104};$$

and seeing that these two determinations fall so nearly within the limits of their respective probable errors, Professor Hall has taken the mean by weight as the final result for his observation, thus giving

$$M = \frac{1}{3093500 \mp 3295}.$$

We may assume this determination to be the best in existence, and it may be a matter of interest here to look at the different values which have been from time to time assigned to the mass of *Mars*.

Authority.	$\frac{1}{m}$
Laplace	1846082
Delambre	2546220
Burckhardt	2680337
Airy, 1828	3734602
Hansen, Olufsen	3200900
Leverrier, I	2994790
„ II	2812526
„ III	2948110

Since discovery of Satellites.

Place.	*Deimos* $\frac{1}{m}$	*Phobos* $\frac{1}{m}$
	3054000	
Washington	3095313	3078456
Cambridge, U.S.	3023319	3039643
Glasgow, U.S.	3024348	3400630
Pulkowa	3146996	......

Laplace, in the *Mécanique Céleste*, gives a value based on the assumption that the mass of the planets varies inversely as their

distances from the Sun. This was afterwards reduced by Delambre. Burckhardt slightly increased the value, which Hansen and Olufsen very greatly decreased in their Tables of the Sun. Le Verrier at different times has used various values for m. Commencing with the value given by Burckhardt, he found that it had to be multiplied by the factor 0·895. In vol. iv. of the *Annales de l'Observatoire* he gives a most probable value, and this was again changed in vol. xi. of the same publication.

The determination of this important factor would be materially improved by observations we may hope to make this year, by which a better knowledge of the periodic times of the satellites will be obtained.

Various estimations of the brightness of the satellites have been made, ranging from the 11th to the 15th magnitude in the case of *Deimos*. With respect to *Phobos* much uncertainty has been expressed, but at the same time the opinion seems to be that it is rather brighter than the outer satellite.

Your Medallist mentions having, on August 17, 1877, observed a fixed star which was mistaken for *Deimos*, and thinking that a determination of its magnitude might be of interest to the Society, I requested Dr. Copeland, if possible, to observe it, and I have received the following report:—

January 16, 1879. Altitude of star, 13°±. I noted "Hall's star is about $11\frac{1}{2}$ magnitude, not seen in finders." Stars about 1 m. brighter I could see well in the finder. In the $15\frac{1}{4}$-inch the star bore illumination of wires well, the place was roughly determined, and agrees with Professor Hall's place within $1^s{\cdot}5$ and $1'{\cdot}1$. An accurate reduction will probably reduce this discordance; the more so as the comparison involves a reduction to 1800, in order to use the Berlin Star Map.*

Your Medallist states that this star was a little brighter than *Deimos* at the time he observed it. The above observation is therefore confirmatory of his estimation.

Professor Hall closes his report by giving data for the computation of Ephemerides of the satellites for the present year, when Mars will have a comparatively favourable declination, 18° north. The estimated brightness on October 10 will be 0·63, and on November 4, 0·73, the unit being the brightness on October 1, 1877.

And your Medallist concludes by giving examples of the computation, using the Table prepared for this purpose.

And now, Mr. Hind, may I request you, as the Foreign

* Since writing this I have received another observation of the star, in which the observation note runs thus: "Hall's star is quite 11th mag.; could be well seen when running along the bright wire [of micrometer], which was very well illuminated with the maximum brightness."—R. C., Jan. 27, 1879.

Nothing can be made of the other star this season, as it is hopelessly lost in the twilight. It will be an admirable popular object, as it is only about 7′ or 8′ from a 6-mag. star, and therefore can be readily found with small instruments.

Secretary of the Society, to place this medal in the hands of the Minister of the United States, to be transmitted to Professor Asaph Hall, as the highest mark of esteem in the gift of the Royal Astronomical Society.

Assure him at the same time of the deep interest that we in England have ever felt in watching the progress of our beloved science in the hands of our cousins in the Far West.